

REL Southwest Ask A REL Response

Math

May 2021

Question:

What are effective programs for increasing high school math achievement in high-minority or high-poverty schools?

Response:

Thank you for the questions you submitted to our REL Reference Desk. We have prepared the following memo with research references to help answer your questions. For each reference, we provide an abstract, excerpt, or summary written by the study's author or publisher. Following an established Regional Educational Laboratory (REL) Southwest research protocol, we conducted a search for research reports as well as descriptive study articles on effective programs that increase high school math achievement in high-minority or high-poverty schools.

We have not evaluated the quality of references and the resources provided in this response. We offer them only for your reference. Also, we searched the references in the response from the most commonly used resources of research, but they are not comprehensive, and other relevant references and resources may exist. References provided are listed in sections with sources in each section in alphabetical order, not necessarily in order of relevance. We do not include sources that are not freely available to the requestor.

Research References

Byun, S., Irvin, M. J., & Bell, B. A. (2015). Advanced math course taking: Effects on math achievement and college enrollment. *Journal of Experimental Education*, 83(4), 439–468. <https://eric.ed.gov/?id=EJ1071098>. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4620065/>.

From the ERIC abstract: “Using data from the Educational Longitudinal Study of 2002–2006, the authors investigated the effects of advanced math course taking on math achievement and college enrollment and how such effects varied by socioeconomic status and race/ethnicity. Results from propensity score matching and sensitivity analyses showed that advanced math course taking had positive effects on math achievement and college enrollment. Results also demonstrated that the effect of advanced math course

taking on math achievement was greater for low socioeconomic status students than for high socioeconomic status students, but smaller for Black students than for White students. No interaction effects were found for college enrollment. Limitations, policy implications, and future research directions are discussed.”

Early, D. M., Berg, J. K., Alicea, S., Si, Y., Aber, J. L., Ryan, R. M., & Deci, E. L. (2016). The impact of Every Classroom, Every Day on high school student achievement: Results from a school-randomized trial. *Journal of Research on Educational Effectiveness*, 9(1), 3–29. <https://eric.ed.gov/?id=EJ1089961>. Retrieved from <https://files.eric.ed.gov/fulltext/EJ1089961.pdf>.

From the ERIC abstract: “Every Classroom, Every Day (ECED) is a set of instructional improvement interventions designed to increase student achievement in math and English/language arts (ELA). ECED includes three primary components: (a) systematic classroom observations by school leaders, (b) intensive professional development and support for math teachers and instructional leaders to reorganize math instruction, assessment, and grading around mastery of benchmarks, and (c) a structured literacy curriculum that supplements traditional English courses, with accompanying professional development and support for teachers surrounding its use. The present study is a two-year trial, conducted by independent researchers, which employed a school-randomized design and included 20 high schools (10 treatment; 10 control) in five districts in four states. The students were ethnically diverse and most were eligible for free or reduced-price lunch. Results provided evidence that ECED improved scores on standardized tests of math achievement, but not standardized tests of ELA achievement. Findings are discussed in terms of differences between math and ELA and of implications for future large-scale school-randomized trials.”

Hill, K. K., Bicer, A., & Capraro, R. M. (2017). Effect of teachers’ professional development from MathForward™ on students’ math achievement. *International Journal of Research in Education and Science*, 3(1), 67–74. <https://eric.ed.gov/?id=EJ1126679>

From the ERIC abstract: “MathForward™, developed in 2004-2005 in cooperation with the Richardson (TX) Independent School District, was implemented nationwide in 2007. The program integrates TI technology and professional development while focusing on student achievement and teacher efficacy. This study investigated the effect of the MathForward™ program on student achievement scores of Algebra I students from a southeast Texas high school. The specific purpose of this study was to understand whether there was an effect on students’ STARR mathematics scores, accounting for teacher professional development and years of experience. To do this, structural equation modeling (SEM) in M-plus was employed. The result of the present study showed that our model fits well to the data and the explained variance of students’ mathematics achievement ($R^2 = 0.14$).”

Irvin, M., Byun, S., Smiley, W. S., & Hutchins, B. C. (2017). Relation of opportunity to learn advanced math to the educational attainment of rural youth. *American Journal of Education*, 123(3), 475–510. <https://eric.ed.gov/?id=EJ1139181>. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6586243/>.

From the ERIC abstract: “Our study examined the relation of advanced math course taking to the educational attainment of rural youth. We used data from the Educational Longitudinal Study of 2002. Regression analyses demonstrated that when previous math achievement is accounted for, rural students take advanced math at a significantly lower rate than urban students. Compared with urban students, rural students have less change in their math achievement from tenth to twelfth grade and are less likely to be enrolled in a 4-year college 2 years postsecondary, and these differences are explained by advanced math course taking. Limitations, implications, and future research directions are discussed.”

Kim, S., Wallsworth, G., Xu, R., Schneider, B., Frank, K., Jacob, B., & Dynarski, S. (2019). The impact of the Michigan Merit Curriculum on high school math course-taking. *Educational Evaluation and Policy Analysis*, 41(2), 164–188. <https://eric.ed.gov/?id=EJ1213935>

From the ERIC abstract: “Michigan Merit Curriculum (MMC) is a statewide college-preparatory policy that applies to the high school graduating class of 2011 and later. Using detailed Michigan high school transcript data, this article examines the effect of the MMC on various students’ course-taking and achievement outcomes. Our analyses suggest that (a) post-MMC cohorts took and passed approximately 0.2 additional years’ of math courses, and students at low socioeconomic status (SES) schools drove nearly all of these effects; (b) post-policy students also completed higher-level courses, with the largest increase among the least prepared students; (c) we did not find strong evidence on students’ ACT math scores; and (d) we found an increase in college enrollment rates for post-MMC cohorts, and the increase is mostly driven by well-prepared students.”

Montemayor, D., Kupczynski, L., & Mundy, M.-A. (2015). Achievement and experiences of first and second-generation students in a rural south Texas high school. *Journal of Instructional Pedagogies*, 16, 1–10. <https://eric.ed.gov/?id=EJ1069388>

From the ERIC abstract: “Hispanic immigrant students face several challenges to academic success. The purpose of this sequential explanatory research was to identify academic differences that existed between first and second generation Hispanic immigrant students on the 10th grade Geometry End of Course scores in a public, rural high school in south Texas and to focus on the students’ experiences in school. While no significant differences were found quantitatively, the qualitative analysis found that the participants had not encountered major obstacles as depicted in the review of the literature. Rather they utilized a resilient social network to counter obstacles and have positive school experiences.”

Nagle, K., Pratt-Williams, J., Schmidt, R., Swantek, C., Lyulchenko, M., & McGhee, R. (2016). *Evaluation of the Rural Math Excel Partnership Project final report*. SRI International. <https://eric.ed.gov/?id=ED579268>

From the ERIC abstract: “This is the final external evaluation report prepared by SRI International for the Rural Math Excel Partnership (RMEP) project, an investing in innovation (i3) development project funded by the U.S. Department of Education.

Operated by Virginia Advanced Study Strategies, Inc. (VASS), the RMEP project included six rural school districts (LEAs) in five Virginia counties as partners. The project goal was to develop and implement a model of shared responsibility among families, math teachers, and communities in rural areas to prepare students enrolled in Algebra I, Geometry, Algebra II, and Algebra Functions and Data Analysis (AFDA) courses for success in advanced high school and postsecondary STEM studies. The long term outcome was for students to leave school ready, at a minimum, to enroll in postsecondary programs focused on technician-level careers in STEM-related fields considered important to the regional rural economy. Due to low levels of implementation by some teachers in project years 1 and 2, in fall 2015 (year 3) the RMEP team focused their supports and services on a group of 24 high-implementation teachers in the seven middle and seven high schools. Key implementation and impact findings were the RMEP team completed five of the six core implementation activities meeting the standard of performance set by the evaluation team; student and family access to technology did not meet performance standards. It was difficult and time consuming to locate students and families in need of tablets and broadband access at the 14 schools and then to provide these individuals with the necessary services in their homes. Furthermore, district firewalls, teacher comfort level with technology, and registration requirements for the MARi online video platform created significant delays for the RMEP project throughout Year 2. By the end of the project's third year, however, RMEP provided technology access to all the students and their families of the 24 teachers. Willingness of individual teachers to perform their role in the model of shared responsibility varied, especially in the number of videos that teachers assigned to students and their efforts to hold Family Math Nights. Although full implementation of the model was restricted to a single semester, there was evidence that this higher level of support was beginning to have positive impacts on the teachers in terms of video assignments and student completion of these assignments. Evaluations from families and students showed that participating in RMEP-related events were useful and worth their time, though attendance was lower than expected for these events. Teachers and community members reported that organizing these events required a large time commitment and that they needed more help in identifying ways to increase attendance. SRI evaluators found that the RMEP project had no impact on students' achievement or attitudes by the end of 2015. Possible reasons included differences between the content knowledge that the Virginia Standards of Learning (SOL) exams assess and the content emphasized by the RMEP project. Evaluators were not able to limit the sample to only those students whose teachers implemented the intervention in the 2015-16 school year (the high-implementing teachers). The small sample size of students may not have been large enough to detect a very small effect. Key model components were not fully implemented until fall 2015, an insufficient time period for the intervention to have a significant impact on the targeted outcomes. Nevertheless, the RMEP project can serve as an illustrative example for other such initiatives, and suggests that similar projects should consider level of participant buy-in, anticipate and be able to troubleshoot technology access issues, and provide enough time as well as staff support for full implementation.”

Snipes, J., Huang, C.-W., Jaquet, K., & Finkelstein, N. (2015). *The effects of the Elevate Math summer program on math achievement and algebra readiness* (REL 2015-096). U.S. Department of Education, Institute of Education Sciences, National Center for Education

Evaluation and Regional Assistance (NCEE), Regional Educational Laboratory West.
<https://eric.ed.gov/?id=ED558157>

From the ERIC abstract: “The Effects of the Elevate Math summer program on math achievement and algebra readiness: This randomized trial examined the effects of the Elevate Math summer program on math achievement and algebra readiness, as well as math interest and self-efficacy, among rising 8th grade students in California’s Silicon Valley. The Elevate Math summer math program targets students who score in the range between “high basic” and “low proficient” on state math tests. It consists of 19 days of mathematics instruction, consisting of three hours per day in traditional classroom instruction and one hour per day using Khan Academy (a free online learning system). During summer 2014, students were randomly assigned to a treatment group that received access to the program at the beginning of the summer or to a control group that received access to the program later in the summer. End-of-program test scores and survey responses of students in the treatment group were compared with those of students in the control group prior to their exposure to the program. Treatment group students scored significantly higher than the control group (4 points or 0.7 standard deviation) on a test of algebra readiness. They were also significantly more likely (29 percent versus 12 percent) to reach achievement thresholds associated with success in algebra I. However, treatment and control groups did not show significant differences in terms of math interest or self-efficacy. The results show that the Elevate Math summer program can significantly improve student math achievement and algebra readiness; however, 70 percent of program participants were still not ready for algebra I content. This suggests that summer math programs such as Elevate Math’s may be important tools for improving math achievement among rising eighth grade students, but most targeted students will need additional support in order to ensure success in algebra.”

REL Southwest Note: What Works Clearinghouse (WWC) rating states, “Meets WWC standards without reservations because it is a randomized controlled trial with low attrition.”

Star, J. R., Caronongan, P., Foegen, A., Furgeson, J., Keating, B., Larson, M. R., Lyskawa, J., McCallum, W. G., Porath, J., & Zbiek, R. M. (2015). *Teaching strategies for improving algebra knowledge in middle and high school students* (NCEE 2015-4010). U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance (NCEE).
https://ies.ed.gov/ncee/wwc/Docs/PracticeGuide/WWC_Algebra_PG_Revised_02022018.pdf

From the ERIC abstract: “Mastering algebra is important for future math and postsecondary success. Educators will find practical recommendations for how to improve algebra instruction in the What Works Clearinghouse (WWC) practice guide, “Teaching Strategies for Improving Algebra Knowledge in Middle and High School Students”. The methods and examples included in the guide focus on helping students analyze solved problems, recognize structure, and utilize alternative approaches to solving algebra problems. Each recommendation includes the level of supporting research evidence behind it, examples to use in class, and solutions to potential

implementation roadblocks. Teachers can implement these strategies in conjunction with existing standards or curricula. In addition, these strategies can be utilized for all students learning algebra in grades 6-12 and in diverse contexts, including during both formative and summative assessment. Administrators and professional development providers can use the guide to implement evidence-based instruction and align instruction with state standards or to prompt teacher discussion in professional learning communities.”

REL Southwest Notes: This publication was revised in January 2019 and can be accessed using the “retrieved from” hyperlink above. Also, the WWC rating states, “Ineligible for review because it does not use an eligible design.”

What Works Clearinghouse Intervention Reports to consult

What Works Clearinghouse. (2007). *UCSMP Algebra*. *What Works Clearinghouse Intervention Report*. U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance (NCEE).
<https://eric.ed.gov/?id=ED499301>

From the ERIC abstract: “‘University of Chicago School Mathematics Project (UCSMP) Algebra,’ designed to increase students’ skills in algebra, is appropriate for students in grades 7-10, depending on the students’ incoming knowledge. This one-year course highlights applications, uses statistics and geometry to develop the algebra of linear equations and inequalities, and includes probability concepts in conjunction with algebraic fractions. The curriculum emphasizes graphing, while manipulation with rational algebraic expressions is delayed until later courses. This curriculum uses the ‘UCSMP’ textbook. The What Works Clearinghouse (WWC) reviewed three studies on ‘UCSMP Algebra.’ Of these, two studies met WWC evidence standards with reservations and one study did not meet WWC evidence screens. One study of ‘UCSMP Algebra’ first edition, comparing it with ‘Saxon Math,’ and one study of ‘UCSMP Algebra’ second edition, comparing it to traditional curricula, met WWC evidence standards with reservations. The two studies included more than 200 middle- and high-school students in four rural, suburban, and urban districts in the West, Midwest, Northeast, and South. Based on the results of these two studies, the WWC found potentially positive effects on students’ math achievement.”

What Works Clearinghouse. (2017). *I CAN Learn®*. *What Works Clearinghouse Intervention Report*. U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance (NCEE).
<https://eric.ed.gov/?id=ED575354>

From the ERIC abstract: “‘I CAN Learn’® is a computer-based math curriculum for students in middle school, high school, and college. It provides math instruction through a series of interactive lessons that students work on individually at their own computers. Students move at their own pace and must demonstrate mastery of each concept before progressing to the next one. Classroom teachers may provide individual, small-group, or whole-class instruction based on students’ performance on the software program. This review focuses on studies of ‘I CAN Learn’®’s primary courses, which include

‘Fundamentals of Math’ and ‘Pre-Algebra.’ The What Works Clearinghouse (WWC) identified one study of ‘I CAN Learn’[®] that both falls within the scope of the Primary Mathematics topic area and meets WWC group design standards. No studies meet WWC group design standards without reservations, and one study meets WWC group design standards with reservations. This study included 9,886 students in eighth grade in one school district. ‘I CAN Learn’[®] had no discernible effects on the mathematics test scores of eighth-grade students in primary mathematics courses. The following are appended: (1) Research details for Kerstyn (2002); (2) Outcome measures for the mathematics achievement domain; (3) Findings included in the rating for the mathematics achievement domain; and (4) Description of supplemental findings for the mathematics achievement domain.”

Additional Organization to Consult

National Council of Teachers of Mathematics (NCTM) – <http://www.nctm.org/>

From the website: “Founded in 1920, the National Council of Teachers of Mathematics (NCTM) is the world’s largest mathematics education organization, with 60,000 members and more than 230 Affiliates throughout the United States and Canada.”

REL Southwest Note: Relevant NCTM research briefs and clips that “provide a foundation for taking what the research says about mathematics teaching and learning to teachers, administrators, school boards and parents” can be accessed at <https://www.nctm.org/Research-and-Advocacy/research-briefs-and-clips/>. These briefs and clips “provide concise statements about classroom relevant research with companion Briefs that provide additional background and research references.”

Methods

Keywords and Search Strings

The following keywords and search strings were used to search the reference databases and other sources:

- [(“increasing high school math achievement” AND “high minority” OR “high poverty”)]
- [(“increasing high school math achievement” AND “rural schools” OR “rural districts”)]
- high school math achievement(“methods” OR “programs” OR “activities”)
- high school math interventions AND achievement
- ACT achievement(“methods” OR “programs” OR “activities”)
- SAT achievement(“methods” OR “programs” OR “activities”)
- improving ACT outcomes
- improving ACT performance
- improving ACT scores
- improving SAT outcomes
- improving SAT performance
- improving SAT scores

Databases and Resources

We searched [ERIC](#) for relevant, peer-reviewed research references. ERIC is a free online library of more than 1.8 million citations of education research sponsored by the Institute of Education Sciences (IES). Additionally, we searched the [What Works Clearinghouse](#).

Reference Search and Selection Criteria

When we were searching and reviewing resources, we considered the following criteria:

- *Date of the publication:* References and resources published from 2006 to present were included in the search and review.
- *Search priorities of reference sources:* Search priority is given to study reports, briefs, and other documents that are published and/or reviewed by IES and other federal or federally funded organizations, academic databases, including ERIC, EBSCO databases, JSTOR database, PsychInfo, PsychArticle, and Google Scholar.
- *Methodology:* The following methodological priorities/considerations were given in the review and selection of the references: (a) study types—randomized control trials, quasi-experiments, correlational studies, descriptive data analyses, literature reviews, mixed methods analyses, and so forth; (b) target population, samples (representativeness of the target population, sample size, volunteered or randomly selected, and so forth), study duration, and so forth; and (c) limitations, generalizability of the findings and conclusions, and so forth.

This memorandum is one in a series of quick-turnaround responses to specific questions posed by stakeholders in the Southwest Region (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas), which is served by the Regional Educational Laboratory (REL) Southwest at AIR. This memorandum was prepared by REL Southwest under a contract with the U.S. Department of Education’s Institute of Education Sciences (IES), Contract ED-IES-91990018C0002, administered by AIR. Its content does not necessarily reflect the views or policies of IES or the U.S. Department of Education nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.